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Designing proxies for stock market indices is computationally hard

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SIAM : Society for Industrial and Applied Mathematics

Publisher Society for Industrial and Applied Mathematics Philadelphia, PA, USA

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REFERENCES

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1 G. J. "ALEXANDER, W. F. SHARPE, AND J. V. BAILEY, Fundamentals of investments, Prentice-Hall, Upper Saddle River, N J, 2nd ed., 1993.

2 T. M. COVER, Universal portfolios, Mathematical Finance, 1 (1991), pp. 1-29.

3 T. M. COVER AND E. ORDENTLICH, Universal portfolios with side in]ormation, IEEE Transactions on Information Theory, 42 (1996), pp. 348-363.

INDEX TERMS

Primary Classification:
J. Computer Applications
J.1 ADMINISTRATIVE DATA PROCESSING
Subjects: Financial (e.g., EFTS)

Additional Classification:
F. Theory of Computation
F.2 ANALYSIS OF ALGORITHMS AND PROBLEM COMPLEXITY

Designing Proxies for Stock Market Indices is Computationally Hard

(Abstract)

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1 Introduction

Market indices are widely used to track the performance of stocks or to design investment portfolios [1]. This paper initiates a rigorous mathematical study of the computational complexity of the art of designing proxies for such indices. While there are several results on selecting such proxies (or portfolios) in an on-line manner (see, for example, [2] and [3]), we look at off-line algorithms for designing proxies based on historical data. In particular, we show that all combinations of three fundamental problems (such as tracking or outperforming a full market index) with four commonly-used indices give NP-complete problems, so are computationally hard.

To formally define market indices, let $\mathcal{B}$ be a set of b stocks in a market. Let $S_{i,t} \geq 0$ be the price of the i-th stock at time t. Let w_i be the number of outstanding shares of the i-th stock. We assume that w_i does not change with time. This paper discusses computational complexity issues regarding four kinds of market indices currently in use [1]. These indices are calculated by the following formulas, which can be multiplied by arbitrary constants to arrive at desired starting index values at time 0.

- The *price-weighted index* of $\mathcal{B}$ at time t is

$$\Phi_1(\mathcal{B}, t) = \frac{\sum_{i=1}^{b} S_{i,t}}{b}.$$

The Dow Jones Industrial Average is calculated in this manner for some $\mathcal{B}$ consisting of thirty stocks.

- The *value-weighted index* of $\mathcal{B}$ at time t is

$$\Phi_2(\mathcal{B}, t) = \frac{\sum_{i=1}^{b} w_i \cdot S_{i,t}}{\sum_{i=1}^{b} w_i \cdot S_{i,0}}.$$

*Supported in part by NSF Grant CCR-9531028.
†Supported in part by NSF Grant CCR-9409945 and Texas Advanced Research Program Grant 1997-003594-019.

The Standard & Poor's 500 is computed in this way with respect to 500 stocks.

- The *equal-weighted index* of $\mathcal{B}$ at time t is

$$\Phi_3(\mathcal{B}, t) = \sum_{i=1}^{b} \frac{S_{i,t}}{S_{i,0}}.$$

The index published by the Indicator Digest is calculated by this method, involving stocks listed on the New York Stock Exchange.

- The *price-relative index* of $\mathcal{B}$ at time t is

$$\Phi_4(\mathcal{B}, t) = \left(\prod_{i=1}^{b} \frac{S_{i,t}}{S_{i,0}} \right)^{\frac{1}{b}}.$$

The Value Line Index is computed by this formula.

There are numerous reasons why stock investors and money managers would want to invest in a subset of stocks rather than those of a whole market [1]. For instance, small investors certainly do not have sufficient capital to invest in every stock in the market. Logically, such investors would attempt to choose a small subset of stocks which hopefully can perform roughly as well as or even outperform the market as a whole. They then face difficult trade-offs between returns and risks. For these and other reasons of optimization, we formulate three natural computational problems for the design of market indices. Given a market $\mathcal{M}$ consisting of m stocks, we wish to choose a subset $\mathcal{M}_k$ of at most k stocks and calculate an index of $\mathcal{M}_k$, which is called a *k-proxy* of the corresponding index of the whole market $\mathcal{M}$ (we sometimes refer to $\mathcal{M}_k$ as a *portfolio*). Our goal is to choose $\mathcal{M}_k$ so that the resulting k-proxy tracks or outperforms the corresponding index of $\mathcal{M}$. This paper shows that designing proxies for the above four indices based on historical data is computationally hard.

2 Problem Formulations

In this section we formally define three basic problems related to selecting k-proxies, or portfolios.

PROBLEM 1. (*tracking an index*)

Input: A market $\mathcal{M}$ of m stocks, their prices $S_{i,t} \geq 0$ for $t = 0, \ldots, f$, their numbers w_i of outstanding shares, a real $\epsilon_1 > 0$, an integer $k > 0$, and some $j \in \{1, 2, 3, 4\}$ to indicate the desired type of index.

Output: A subset $\mathcal{M}_k$ of at most k stocks in $\mathcal{M}$ such that for all $t = 1, \ldots, f$,

$$\left| \frac{\Phi_j(\mathcal{M}_k, t)}{\Phi_j(\mathcal{M}_k, 0)} - \frac{\Phi_j(\mathcal{M}, t)}{\Phi_j(\mathcal{M}, 0)} \right| \leq \epsilon_1 \cdot \frac{\Phi_j(\mathcal{M}, t)}{\Phi_j(\mathcal{M}, 0)}.$$

PROBLEM 2. (*outperforming an index*)

Input: A market $\mathcal{M}$ of m stocks, their prices $S_{i,t} \geq 0$ for $t = 0, \ldots, f$, their numbers w_i of outstanding shares, a real $\epsilon_2 \geq 0$, an integer $k > 0$, and some $j \in \{1, 2, 3, 4\}$ to indicate the desired type of index.

Output: A subset $\mathcal{M}_k$ of at most k stocks in $\mathcal{M}$ such that for all $t = 1, \ldots, f$,

$$\frac{\Phi_j(\mathcal{M}_k, t)}{\Phi_j(\mathcal{M}_k, 0)} \geq (1 + \epsilon_2) \cdot \frac{\Phi_j(\mathcal{M}, t)}{\Phi_j(\mathcal{M}, 0)}.$$

For the final problem, we need a few extra definitions in order to analyze the *volatility* of a set of stocks. Let $\mathcal{B}$ be a set of stocks as defined in §1.

- The *one-period return* of Φ_j for $\mathcal{B}$ at time $t \geq 1$ is

$$R_j(\mathcal{B}, t) = \ln \frac{\Phi_j(\mathcal{B}, t)}{\Phi_j(\mathcal{B}, t-1)}.$$

- The *average return* of Φ_j for $\mathcal{B}$ up to time $t \geq 1$ is

$$\overline{R}_j(\mathcal{B}, t) = \frac{\sum_{i=1}^{t} R_j(\mathcal{B}, i)}{t}.$$

- The *volatility* of Φ_j for $\mathcal{B}$ up to time $t \geq 2$ is

$$\Delta_j(\mathcal{B}, t) = \sqrt{\frac{\sum_{i=1}^{t} \left(R_j(\mathcal{B}, i) - \overline{R}_j(\mathcal{B}, t)\right)^2}{t-1}}.$$

PROBLEM 3. (*sacrificing return for less volatility*)

Input: A market $\mathcal{M}$ of m stocks, their prices $S_{i,t} \geq 0$ for $t = 0, \ldots, f$, their numbers w_i of outstanding shares, two reals $\alpha, \beta > 0$, an integer $k > 0$, and some $j \in \{1, 2, 3, 4\}$ to indicate the desired type of index.

Output: A subset $\mathcal{M}_k$ of at most k stocks in $\mathcal{M}$ such that

$$\frac{\Phi_j(\mathcal{M}_k, t)}{\Phi_j(\mathcal{M}_k, 0)} \geq \alpha \cdot \frac{\Phi_j(\mathcal{M}, t)}{\Phi_j(\mathcal{M}, 0)} \text{ for all } t = 1, \ldots, f;$$

$$\Delta_j(\mathcal{M}_k, s) \leq \beta \cdot \Delta_j(\mathcal{M}, s) \text{ for all } s = 2, \ldots, f.$$

3 Results

In this abstract, we simply quote the main results — all the proofs can be found in the full paper.

THEOREM 3.1. *Let ϵ_1 be any error bound satisfying $0 < \epsilon_1 < 1$ and specified using $n^{O(1)}$ bits in fixed point notation. Then the tracking problem with error bound ϵ_1 is NP-hard for the price-weighted index, value-weighted index, and equal-weighted index.*

THEOREM 3.2. *Let ϵ_2 be any value satisfying $0 < \epsilon_2 < n^c$ for some constant c. Then the problem of outperforming the market average with bound ϵ_2 is NP-hard for the price-weighted index, value-weighted index, equal-weighted index, and price-relative index.*

THEOREM 3.3. *Let α and β be values expressed using $n^{O(1)}$ bits in fixed-point binary notation, and satisfying $0 < \alpha \leq n^{O(1)}$ and $\beta = \Omega\left(\frac{\log k}{\log n}\right)$. Then the problem of sacrificing return for less volatility is NP-complete for the price-weighted index, value-weighted index, equal-weighted index, and price-relative index.*

The one result that must be separated from the above is the tracking problem for the price-relative index. In order for our reduction to work in this case, we were required to reduce the range of possible values for ϵ_1.

THEOREM 3.4. *Let ϵ_1 be any error bound satisfying $0 < \epsilon_1 < 1$ and specified using $O(\log n)$ bits in fixed point notation. Then the tracking problem for a price-relative index with error bound ϵ_1 is NP-hard.*

References

[1] G. J. ALEXANDER, W. F. SHARPE, AND J. V. BAILEY, *Fundamentals of Investments*, Prentice-Hall, Upper Saddle River, NJ, 2nd ed., 1993.

[2] T. M. COVER, *Universal portfolios*, Mathematical Finance, 1 (1991), pp. 1–29.

[3] T. M. COVER AND E. ORDENTLICH, *Universal portfolios with side information*, IEEE Transactions on Information Theory, 42 (1996), pp. 348–363.

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181 Session: Representing text chunks
Erik F. Tjong Kim Sang, Jorn Veenstra
June 1999 **Proceedings of the ninth conference on European chapter of the Association for Computational Linguistics**
Full text available: pdf(560.85 KB) Publisher Site
Additional Information: full citation, abstract, references, citings

Dividing sentences in chunks of words is a useful preprocessing step for parsing, information extraction and information retrieval. (Ramshaw and Marcus, 1995) have introduced a "convenient" data representation for chunking by converting it to a tagging task. In this paper we will examine seven different data representations for the problem of recognizing noun phrase chunks. We will show that the the data representation choice has a minor influence on chunking performance. However, equipped with ...

182 TnT: a statistical part-of-speech tagger
Thorsten Brants
April 2000 **Proceedings of the sixth conference on Applied natural language processing**
Full text available: pdf(690.66 KB) Publisher Site
Additional Information: full citation, abstract, references, citings

Trigrams'n'Tags (TnT) is an efficient statistical part-of-speech tagger. Contrary to claims found elsewhere in the literature, we argue that a tagger based on Markov models performs at least as well as other current approaches, including the Maximum Entropy framework. A recent comparison has even shown that TnT performs significantly better for the tested corpora. We describe the basic model of TnT, the techniques used for smoothing and for handling unknown words. Furthermore, we present evaluat ...

183 Squibs and discussions: Unsupervised named entity recognition using syntactic and semantic contextual evidence
Alessandro Cucchiarelli, Paola Velardi
March 2001 **Computational Linguistics**, Volume 27 Issue 1
Full text available: pdf(572.52 KB) Publisher Site
Additional Information: full citation, abstract, references

Proper nouns form an open class, making the incompleteness of manually or automatically learned classification rules an obvious problem. The purpose of this paper is twofold: first,

to suggest the use of a complementary "backup" method to increase the robustness of any hand-crafted or machine-learning-based NE tagger; and second, to explore the effectiveness of using more fine-grained evidence--namely, syntactic and semantic contextual knowledge---in classifying NEs.

184 Automatic verb classification based on statistical distributions of argument structure
Paola Merlo, Suzanne Stevenson
September 2001 **Computational Linguistics**, Volume 27 Issue 3

Full text available: pdf(2.84 MB) Additional Information: full citation, abstract, references, citings
Publisher Site

Automatic acquisition of lexical knowledge is critical to a wide range of natural language processing tasks. Especially important is knowledge about verbs, which are the primary source of relational information in a sentence---the predicate-argument structure that relates an action or state to its participants (i.e., who did what to whom). In this work, we report on supervised learning experiments to automatically classify three major types of English verbs, based on their argument structure--sp ...

185 Automatic selection of class labels from a thesaurus for an effective semantic tagging of corpora
Alessandro Cucchiarelli, Paola Velardi
March 1997 **Proceedings of the fifth conference on Applied natural language processing**

Full text available: pdf(706.88 KB) Additional Information: full citation, abstract, references, citings
Publisher Site

It is widely accepted that tagging text with semantic information would improve the quality of lexical learning in corpus-based NLP methods. However available on-line taxonomies are rather entangled and introduce an unnecessary level of ambiguity. The noise produced by the redundant number of tags often overrides the advantage of semantic tagging. In this paper we propose an automatic method to select from WordNet a subset of domain-appropriate categories that effectively reduce the overambiguit ...

186 Fast statistical parsing of noun phrases for document indexing
Chengxiang Zhai
March 1997 **Proceedings of the fifth conference on Applied natural language processing**

Full text available: pdf(788.76 KB) Additional Information: full citation, abstract, references, citings
Publisher Site

Information Retrieval (IR) is an important application area of Natural Language Processing (NLP) where one encounters the genuine challenge of processing large quantities of unrestricted natural language text. While much effort has been made to apply NLP techniques to IR, very few NLP techniques have been evaluated on a document collection larger than several megabytes. Many NLP techniques are simply not efficient enough, and not robust enough, to handle a large amount of text. This paper propos ...

187 A statistical profile of the Named Entity task
David D. Palmer, David S. Day
March 1997 **Proceedings of the fifth conference on Applied natural language processing**

Full text available: pdf(420.60 KB) Additional Information: full citation, abstract, references, citings
Publisher Site

In this paper we present a statistical profile of the Named Entity task, a specific information

extraction task for which corpora in several languages are available. Using the results of the statistical analysis, we propose an algorithm for lower bound estimation for Named Entity corpora and discuss the significance of the cross-lingual comparisons provided by the analysis.

188 Industrial/government track: Information awareness: a prospective technical assessment

David Jensen, Matthew Rattigan, Hannah Blau

August 2003 **Proceedings of the ninth ACM SIGKDD international conference on Knowledge discovery and data mining**

Full text available: pdf(987.46 KB) Additional Information: full citation, abstract, references, index terms

Recent proposals to apply data mining systems to problems in law enforcement, national security, and fraud detection have attracted both media attention and technical critiques of their expected accuracy and impact on privacy. Unfortunately, the majority of technical critiques have been based on simplistic assumptions about data, classifiers, inference procedures, and the overall architecture of such systems. We consider these critiques in detail, and we construct a simulation model that more cl ...

Keywords: TIA, collective classification, information awareness, iterative classification, privacy, ranking classifiers, relational data mining, social network analysis, technology assessment

189 Putting it together: Why the newspaper has a great user interface

Win Treese

December 2003 **netWorker**, Volume 7 Issue 4

Full text available: pdf(95.75 KB) html(11.41 KB) Additional Information: full citation, abstract, index terms

While reading *The Wall Street Journal* this morning, I found myself thinking about the flood of information I get electronically. In many ways, reading the newspaper is still a more pleasant experience than sorting through (virtual) piles of e-mail, newsgroups, online forums, Web sites, and other Internet information sources. Can more of the lessons of newspaper design be applied to online information tools?

190 Viewpoint: The myth of diminishing firms

Geoffrey Sampson

November 2003 **Communications of the ACM**, Volume 46 Issue 11

Full text available: pdf(81.28 KB) html(23.14 KB) Additional Information: full citation, abstract, references, index terms

Economist Ronald Coase was not suggesting that because the size of firms is tied to transaction costs, the lower transaction costs of e-commerce would cause e-businesses to grow smaller and smaller.

191 Accessibility: Computer documentation for senior citizens

Scott Tilley

October 2003 **Proceedings of the 21st annual international conference on Documentation**

Full text available: pdf(180.24 KB) Additional Information: full citation, abstract, references, index terms

The fastest growing market segment of new computer users is senior citizens. For many seniors, the computer is a puzzling device whose inner workings will forever remain a mystery. A lack of understanding of how a computer works doesn't necessarily mean that seniors' interest in using a computer is diminished. But it does mean that most of the

documentation written to help them learn computing skills and use common applications is inappropriate. Based on a series of free seminars conducted in th ...

Keywords: computer documentation, exception-oriented, senior citizens

192 Special issue on machine learning approaches to shallow parsing: Shallow parsing with pos taggers and linguistic features

Beáta Megyesi

March 2002 **The Journal of Machine Learning Research**, Volume 2

Full text available: pdf(220.60 KB) Additional Information: full citation, abstract, references, citings, index terms

Three data-driven publicly available part-of-speech taggers are applied to shallow parsing of Swedish texts. The phrase structure is represented by nine types of phrases in a hierarchical structure containing labels for every constituent type the token belongs to in the parse tree. The encoding is based on the concatenation of the phrase tags on the path from lowest to higher nodes. Various linguistic features are used in learning; the taggers are trained on the basis of lexical information only ...

Keywords: chunking, hidden Markov models, maximum entropy learning, part-of-speech taggers, shallow parsing, transformation-based learning

193 APL in the workstation environment

J. R. Turner

July 1989 **ACM SIGAPL APL Quote Quad , Conference proceedings on APL as a tool of thought**, Volume 19 Issue 4

Full text available: pdf(498.35 KB) Additional Information: full citation, index terms

194 A view from the SIGCPR conference: what have we learned in this decade?

Fred Niederman, Jo Ellen Moore, Susan E. Yager

October 1999 **ACM SIGCPR Computer Personnel**, Volume 20 Issue 4

Full text available: pdf(1.61 MB) Additional Information: full citation, abstract, references

Previous research on computer personnel, or the "people part" of the computer technology equation, has stimulated understanding of the interaction between people and technology. This paper presents the results of quantitative and qualitative analysis of proceedings from the 1991 through 1999 annual conference of the Association for Computing Machinery's Special Interest Group on Computer Personnel Research. The study develops a framework defining the domain of management information systems pers ...

Keywords: computer personnel, framework, research methods

195 Using text processing techniques to automatically enrich a domain ontology

Paola Velardi, Paolo Fabriani, Michele Missikoff

October 2001 **Proceedings of the international conference on Formal Ontology in Information Systems - Volume 2001**

Full text available: pdf(2.16 MB) Additional Information: full citation, abstract, references, citings, index terms

Though the utility of domain Ontologies is now widely acknowledged in an increasing number of domains, several barriers must be overcome before Ontologies become practical and useful tools. A critical issue is the task of identifying, defining, and entering the

concept definitions. In case of large and complex application domains this task can be lengthy, costly, and controversial (since different persons may have different points of view about the same concept). To reduce time, cost (an ...

196 Business process, health care and service industry applications: Simulation of the drug development process: a case study from the pharmaceutical industry
Russell W. Workman
December 2000 **Proceedings of the 32nd conference on Winter simulation**
Full text available: pdf(1.78 MB) Additional Information: full citation, abstract, references

This paper uses a case study from the pharmaceutical industry to show how simulation modeling can be applied to understanding large, highly-complex processes such as drug development. I conclude that simulation provides an enhanced resource planning capability compared with that provided by traditional spreadsheet analysis. This capability difference stems from the ability of a simulation to better reflect the variation which defines such complicated processes. The conditions which facilitate ex ...

197 Cooling and power consideration for semiconductors into the next century
Christian Belady
August 2001 **Proceedings of the 2001 international symposium on Low power electronics and design**
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198 Using multimedia to create instructional pieces for the web
Kathleen Harmeyer, Bill Beck, Kathy Cantrell, Sylvia Sorkin, Donna Tupper
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199 Recruiting IT faculty
Martha Myers, Cathy Beise
September 1999 **Communications of the AIS**
Full text available: pdf(146.55 KB) Additional Information: full citation, references

200 Russian visit to US computers
E. M. Zaitzeff, M. M. Astrahan
November 1959 **Communications of the ACM**, Volume 2 Issue 11
Full text available: pdf(1.28 MB) Additional Information: full citation

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Satu S. Parikh, Gerald L. Lohse

May 1995 **Proceedings of the SIGCHI conference on Human factors in computing systems**

Full text available: html(48.91 KB) Additional Information: full citation, references, citings, index terms

42 WebMate: a personal agent for browsing and searching

Liren Chen, Katia Sycara

May 1998 **Proceedings of the second international conference on Autonomous agents**

Full text available: pdf(969.48 KB) Additional Information: full citation, references, citings, index terms

43 Bounded rationality and adaptive agents in economic modeling

T. Grimm, J. Mitlöhner, W. Schönfeldinger

June 1995 **ACM SIGAPL APL Quote Quad , Proceedings of the international conference on Applied programming languages**, Volume 25 Issue 4

Full text available: pdf(520.18 KB) Additional Information: full citation, abstract, references, citings, index terms

Traditional economic theory sees human economic decisions as rational choices of action to achieve maximum utility. However, economic reality shows that people often behave in ways different from that ideal: actions are not always determined rationally; often they are influenced by other factors, such as chance and tradition. In order to describe the behaviour of economic agents in the real world, we take irrationality and adaptation into account: we present work in progress on a market sim ...

Keywords: adaptive agents, bounded rationality, economic modelling, economic simulation

44 The implications of online investing

Prabhudev Konana, Nirup M. Menon, Sridhar Balasubramanian

January 2000 **Communications of the ACM**, Volume 43 Issue 1

Full text available: pdf(123.87 KB) html(37.58 KB) Additional Information: full citation, references, citings, index terms, review

45 DB-3 (databases): data mining: Framework and algorithms for trend analysis in massive temporal data sets

Sreenivas Gollapudi, D. Sivakumar

November 2004 **Proceedings of the Thirteenth ACM conference on Information and knowledge management**

Full text available: pdf(235.70 KB) Additional Information: full citation, abstract, references, index terms

Mining massive temporal data streams for significant trends, emerging buzz, and unusually high or low activity is an important problem with several commercial applications. In this paper, we propose a framework based on relational records and metric spaces to study such problems. Our framework provides the necessary mathematical underpinnings for this genre of problems, and leads to efficient algorithms in the stream/sort model of massive data sets (where the algorithm makes passes over the d ...

Keywords: data stream algorithms, hierarchically partitioned data, metric approximations, taxonomies, trend analysis

46 Markets and privacy

Kenneth C. Laudon

September 1996 **Communications of the ACM**, Volume 39 Issue 9

Full text available: pdf(231.63 KB) Additional Information: full citation, references, citings, index terms, review

47 Software economics: a roadmap

Barry W. Boehm, Kevin J. Sullivan

May 2000 **Proceedings of the Conference on The Future of Software Engineering**

Full text available: pdf(2.58 MB) Additional Information: full citation, references, citings, index terms

48 Agent oriented programming with Ada'95: application to financial markets

Férial Benachour Hait

March 2000 **ACM SIGAda Ada Letters**, Volume XX Issue 1

Full text available: pdf(684.93 KB) Additional Information: full citation, abstract, references

This paper shows the suitability of Object Oriented Programming language Ada'95 for Agent Oriented Programming. Agent oriented programming relies on the assumption, that a complex distributed software system can be programmed as a set of communicating, interacting, knowledge base entities called (software) agents. In this work we study the financial market case by introducing new modeling and implementation tools in order to simulate and understand some properties of the market evolution process ...

49 Risk analysis: State of the art tutorial II: simulations for financial engineering: efficient simulations for option pricing

Jeremy Staum

December 2003 **Proceedings of the 35th conference on Winter simulation: driving innovation**

Full text available: pdf(183.98 KB) Additional Information: full citation, abstract, references

This paper presents an overview of techniques for improving the efficiency of option pricing simulations, including quasi-Monte Carlo methods, variance reduction, and methods for dealing with discretization error.

50 Common knowledge

John Geanakoplos

March 1992 **Proceedings of the 4th conference on Theoretical aspects of reasoning about knowledge**

Full text available: pdf(3.29 MB) Additional Information: full citation, abstract, references

People, no matter how rational they are, usually act on the basis of incomplete information. If they are rational they recognize their own ignorance and reflect carefully on what they know and what they do not know, before choosing how to act. Furthermore, when rational agents interact, they also think about what the others know, and what the others know about what they know, before choosing how to act. Failing to do so can be disastrous. When the notorious evil genius Professor Moriarty conf ...

51 Holland classifier systems

Andreas Geyer-Schulz

June 1995 **ACM SIGAPL APL Quote Quad , Proceedings of the international conference on Applied programming languages**, Volume 25 Issue 4

Full text available: pdf(1.28 MB) Additional Information: full citation, abstract, references, citings, index terms

A Holland classifier system is an adaptive, general purpose machine learning system which is designed to operate in noisy environments with infrequent and often incomplete feedback. Examples of such environments are financial markets, stock management systems, or chemical processes. In financial markets, a Holland classifier system would develop trading strategies, in a stock management system order heuristics, and in a chemical plant it would perform process control. In this paper we descr ...

Keywords: bucket brigade, classifier system, genetic algorithm, machine learning, triggered operations

52 The department of defense contractor investment policy model

Richard William Barker, Kenneth C. Konwin

December 1983 **Proceedings of the 15th conference on Winter Simulation - Volume 2**

Full text available: pdf(803.06 KB) Additional Information: full citation, abstract, references, index terms

The primary aim of this system dynamics study was to understand aerospace defense contractor investment behavior, and evaluate government policies designed to motivate investment in capital within the current fighter/attack aircraft manufacturing market structure. The approach taken analyzes investment projects and capital equipment expenditure flows that arise as a result of the overall decision framework of the firm. The continuous corporate computer simulation model addresses several of ...

53 Session 9C: evolution, adaptation, and learning II: Learning and exploiting context in agents

Bruce Edmonds

July 2002 **Proceedings of the first international joint conference on Autonomous agents and multiagent systems: part 3**

Full text available: pdf(306.02 KB) Additional Information: full citation, abstract, references, index terms

The use of context can considerably facilitate reasoning by restricting the beliefs reasoned upon to those relevant and providing extra information specific to the context. Despite the use and formalization of context being extensively studied both in AI and ML, context has not been much utilized in agents. This may be because many agents are only applied in a

single context, and so these aspects are implicit in their design, or it may be that the need to explicitly encode information about vari ...

Keywords: biological analogy, cognitive analogy, context, deduction, evolutionary computation, genetic programming, integration, learning

54 Search 2: Evaluating strategies for similarity search on the web
Taher H. Haveliwala, Aristides Gionis, Dan Klein, Piotr Indyk
May 2002 **Proceedings of the eleventh international conference on World Wide Web**

Full text available: pdf(268.54 KB) Additional Information: full citation, abstract, references, citings, index terms

Finding pages on the Web that are similar to a query page (Related Pages) is an important component of modern search engines. A variety of strategies have been proposed for answering Related Pages queries, but comparative evaluation by user studies is expensive, especially when large strategy spaces must be searched (e.g., when tuning parameters). We present a technique for automatically evaluating strategies using Web hierarchies, such as Open Directory, in place of user feedback. We apply this ...

Keywords: evaluation, open directory project, related pages, search, similarity search

55 How open data networks influence business performance and market structure
Lynn A. Streeter, Robert E. Kraut, Henry C. Lucas, Laurence Caby
July 1996 **Communications of the ACM**, Volume 39 Issue 7

Full text available: pdf(2.18 MB) Additional Information: full citation, references, citings, index terms, review

56 The killer app: how to make millions with ground-breaking software
Ian Clark
June 2000 **ACM SIGAPL APL Quote Quad , Proceedings of the international conference on APL-Berlin-2000 conference**, Volume 30 Issue 4

Full text available: pdf(866.51 KB) Additional Information: full citation, abstract, index terms

I've been a programmer for over 30 years, often at the leading edge, never in a classic IT shop. I've worked with several vendors' mainframes, midis and micros, for big firms, small firms, central government, educational establishments, and for myself; in colleges, universities, laboratories and classrooms; in England, in Europe, and in the USA. I've been involved in some total flops, but in one or two real successes too. I could never tell from the outset which it was going to be. The more I se ...

57 Managing Your Money with GnuCash
Robert Merkel
April 2001 **Linux Journal**

Full text available: html(18.36 KB) Additional Information: full citation, abstract, index terms

A tutorial on a powerful, free accounting program.

58 Symmetric and Asymmetric Encryption
Gustavus J. Simmons
December 1979 **ACM Computing Surveys (CSUR)**, Volume 11 Issue 4

Full text available: pdf(2.23 MB) Additional Information: full citation, references, citings, index terms

59 Aggregate operators in probabilistic databases
Robert Ross, V. S. Subrahmanian, John Grant
January 2005 **Journal of the ACM (JACM)**, Volume 52 Issue 1

Full text available: pdf(816.92 KB) Additional Information: full citation, abstract, references, index terms

Though extensions to the relational data model have been proposed in order to handle probabilistic information, there has been very little work to date on handling aggregate operators in such databases. In this article, we present a very general notion of an aggregate operator and show how classical aggregation operators (such as COUNT, SUM, etc.) as well as statistical operators (such as percentiles, variance, etc.) are special cases of this general definition. We devise a formal linear program ...

Keywords: Aggregates, probabilistic relational databases

60 Automatic selection of class labels from a thesaurus for an effective semantic tagging of corpora
Alessandro Cucchiarelli, Paola Velardi
March 1997 **Proceedings of the fifth conference on Applied natural language processing**

Full text available: pdf(708.86 KB) Publisher Site Additional Information: full citation, abstract, references, citings

It is widely accepted that tagging text with semantic information would improve the quality of lexical learning in corpus-based NLP methods. However available on-line taxonomies are rather entangled and introduce an unnecessary level of ambiguity. The noise produced by the redundant number of tags often overrides the advantage of semantic tagging. In this paper we propose an automatic method to select from WordNet a subset of domain-appropriate categories that effectively reduce the overambiguit ...

Results 41 - 60 of 200 Result page: previous 1 2 **3** 4 5 6 7 8 9 10 next

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L4	1837	(updat$4 or add$3 or new$2) near8 (databa$4 or data adj (base$1 or bank$1) or vocabular$4 or grammer$1 or grammar$1 or stock$1 or fund$1) near30 (weight$1 or value$2) and volume and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 17:31
L5	1403	4 and (stock$1 or bond$1 or fund$1 or commodit$3 or trading or trade$1 or financial or securities or investment$1)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 17:36
L6	2	4 and (stock$1 or bond$1 or fund$1 or commodit$3 or trading or trade$1 or financial or securities or investment$1) and weight$1 same (stock or fund) and weight$ and "stock market" and trade and fund$1	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 17:39
L7	13	4 and weight$1 same (symbol or nickname)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 17:39
L8	0	(stock$1 or bond$1 or fund$1 or commodit$3 or trading or trade$1 or financial or securities or investment$1 or "mutual fund" or "mutual funds") and weight same (symbo or nickname same (stock or fund) and weight$ and "stock market" and trade and fund$1) and quote$1 and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:06
L9	8	(stock$1 or bond$1 or fund$1 or commodit$3 or trading or trade$1 or financial or securities or investment$1 or "mutual fund" or "mutual funds") and weight same (symbo or nickname) and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:10
L10	5	(stock$1 or bond$1 or fund$1 or commodit$3 or trading or trade$1 or investment$1 or "mutual fund" or "mutual funds") and weight same (symbo or nickname) and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:08
L11	2	(stock$1 or bond$1 or "mutual fund" or "mutual funds") and weight same (symbo or nickname) and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:09

L12	41	(stock$1 or bond$1 or "mutual fund" or "mutual funds") and weight and (symbo or nickname) and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:11
L13	0	(trading or trade$1) and weight same (symbo or nickname) and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:10
L14	2	portfolio and weight same (symbo or nickname) and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:11
L15	119	(stock$1 or bond$1 or "mutual fund" or "mutual funds") and value$1 and (symbo or nickname) and @ad<"20010809"	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:54
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L17	1	16 and stock$1 and weight same symbol	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:56
L18	66	16 and stock$1 and portfolio	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 18:56
L19	14	16 and stock$1 and portfolio and weight	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 19:08
L20	2099	16 and stock$1 and baseform$1 or (base adj form$1) and weight$6 and (symbol$1 or sym! or nickname$1 or nick adj name$1)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 19:07
L21	0	16 and stock$1 and baseform$1 and weight$6 and (symbol$1 or sym!)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 19:04
L22	104	16 and stock$1 and weight$6 and (symbol$1 or sym!)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 19:05
L23	22228	16 and stock$1 and baseform$1 or (base adj form$1) and weight$6	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 19:08

L24	14	16 and trad$6 and portfolio and weight	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 19:22
L25	14	16 and "stock exchange" and weight$5	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 20:21
L26	992	16 and (offer44 or list$6)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 20:22
L27	148	16 and (stocK$1 or bond$1 or securit$5) near6 (offer$4 or list$6)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	ON	2005/03/20 20:23